CLAIMS

What is claimed is:

1. A method of detecting a signal indicative of a property of a structure in a semiconductor wafer, the method comprising:

   receiving a semiconductor wafer that comprises a test structure, wherein the test structure comprises a first and second region that differ from each other by at least one property and wherein the first region comprises an interface in the wafer;

   oscillating a spot of coherent electromagnetic radiation between the first region and the second region; wherein a penetration depth of the coherent electromagnetic radiation is between a depth of the interface and a thickness of the wafer; and

   using a photodetector to measure intensity of a portion of the electromagnetic radiation reflected during said oscillating; and

   synchronously detecting, at a frequency of said oscillating, an amplitude of an electrical signal generated by the photodetector during measurement by the photodetector.

2. The method of Claim 1 further comprising:

   repeating said acts of (oscillating, using photodetector and synchronously detecting) with electromagnetic radiation of another wavelength.

3. The method of Claim 1 wherein the first region comprises a plurality of dopants, and said property is selected from a group consisting of: depth of an interface between the first region and a well in which the first region is formed, abruptness of a profile of the dopants, and a peak in the dopant profile.

4. The method of Claim 1 further comprising:

   changing at least one process parameter used in fabricating the wafer if said amplitude falls outside a predetermined range.

5. The method of Claim 1 wherein the interface is positioned between a first layer that forms a portion of the front surface and a second layer of semiconductor material located underneath the first layer, wherein the first layer is formed of a dielectric material or of a conductive material.

6. The method of Claim 5 further comprises performing a look-up of a table of predetermined data with said amplitude as input to determine thickness of the first layer.

7. The method of Claim 1 wherein only one of the first region and second region is a doped region and the method further comprises performing a look-up of a table of predetermined data with said amplitude as input to determine a property of the doped region.

8. The method of Claim 7 where said property is selected from the group consisting of:
   depth of an annealed semiconductor junction;
   a dose of implants in said doped region before annealing;
   a dose of implants in said doped region after annealing;
   a doping concentration after annealing;
   abruptness of a profile of doping concentration after annealing; and
   a defect density inside the doped region after annealing.

9. The method of Claim 1 wherein:
   said synchronously detecting is performed in a lock-in amplifier coupled to said photodetector to receive therefrom said electrical signal, said lock-in amplifier being tuned to the predetermined frequency f; and
   said lock-in amplifier detecting said amplitude of fluctuation of said electrical signal.

10. The method of Claim 1 where at least one of said beam and said wafer is kept stationary relative to ground.

11. The method of Claim 1 where a source of said beam and the wafer are both kept stationary relative to ground, and the method further comprises:

using a beam deflector to move the beam relative to the wafer.

12. The method of Claim 1 wherein:

the absorption length of the beam in the wafer is less than one-half of the thickness of the wafer.

13. The method of Claim 1 wherein:

said first region and said second region touch each other at a common boundary.

14. The method of Claim 1 wherein:

said first region and said second region are separated from each other.

15. The method of Claim 1 wherein:

said coherent electromagnetic radiation is substantially of a predetermined wavelength.

16. The method of Claim 1 wherein:

said spot is formed on a first surface at which a doped region is located in said wafer.

17. The method of Claim 1 wherein:

said spot is formed continuously on said wafer.

18. The method of Claim 1 wherein:

said spot is oscillated along a straight line.

19. The method of Claim 1 wherein:

said wafer comprises at least a portion of an integrated circuit, said integrated circuit being in addition to said test structure also comprised in said wafer.

20. The method of Claim 19 further comprising:

forming said portion of integrated circuit and said test structure using at least one common process step.

21. A method of detecting a signal indicative of a property of a structure in a semiconductor wafer, the method comprising:

receiving a semiconductor wafer that comprises a test structure, wherein the test structure comprises a first and second region that differ from each other by at least one property and wherein the first region comprises an interface in the wafer;

oscillating a first spot and a second spot that at least partially overlaps the first spot between the first region and the second region; wherein the first spot is formed by a first beam of coherent electromagnetic radiation that has a first penetration depth between a depth of the interface and a thickness of the wafer, wherein the second spot is formed by a second beam of coherent electromagnetic radiation, wherein the first beam has photon energy lower than a semiconductor bandgap energy and the second beam has photon energy greater than the semiconductor bandgap energy;

using a photodetector to measure intensity of a portion of the first beam reflected during said oscillating; and

synchronously detecting, at a frequency of said oscillating, an amplitude of an electrical signal generated by the photodetector during measurement by the photodetector.

22. The method of Claim 21 wherein the first beam and the second beam are coaxial, and the first spot and the second spot are concentric.

23. The method of Claim 21 wherein the wavelength of the second beam is also sufficiently short to ensure that an absorption length of the second beam in the wafer is less than a thickness of the wafer but greater than a profile of a depth in the wafer.

24. The method of Claim 21 further comprising:

changing a process parameter used in fabricating the wafer if said amplitude falls outside a predetermined range.

25. The method of Claim 21 where a first source of said first beam, a second source of said second beam and the wafer are all kept stationary relative to ground, and the method further comprises:

using a beam deflector to move the first beam and the second beam relative to the wafer.

26. The method of Claim 21 wherein:

wavelengths of the first beam and of the second beam are each sufficiently short to ensure their respective absorption lengths are lower than one-half of the thickness of the wafer.

27. An apparatus for evaluating a semiconductor wafer, the apparatus comprising a patterning tool, an ion implanter located adjacent to the patterning tool, and a measurement tool adjacent to the ion implanter, the measurement tool comprising:

a source of a beam of coherent electromagnetic radiation of absorption length less than a thickness of the wafer but greater than a depth of an interface in the wafer;

means for moving at least one of the beam and a stage carrying the wafer relative to one another to oscillate a spot formed by the beam between a first region and a second region of the wafer; and

a photodetector located in a path of reflection of the beam from the wafer.

28. The apparatus of Claim 27 wherein:

the source of said coherent beam of electromagnetic radiation is a laser.

29. The apparatus of Claim 27 wherein:

the means for moving comprises an acousto-optic deflector located in a path of the beam.

30. The apparatus of Claim 27 wherein:

the means for moving comprises a scanning galvanometer mirror located in a path of the beam.

31. The apparatus of Claim 27 wherein:

the means for moving comprises a piezoelectric actuator attached to the stage.

32. The apparatus of Claim 27 further comprising:

a plurality of additional lasers mounted adjacent to one another at a plurality of positions located along a first line, and said source is mounted adjacent to one of the additional lasers and along the first line;

at least one mirror attached to means for translation along a second line parallel to the first line, and between a plurality of corresponding locations opposite to the plurality of positions of the lasers and said source;

a stage for supporting the wafer, with a front surface of the wafer facing the beam from the mirror at normal incidence thereof;

wherein the means for moving comprises an optical element located along the second line, in a path of the beam reflected by the mirror; and

the apparatus further comprises a beam splitter located along the second line, between the means for moving and the mirror.

33. The apparatus of Claim 27 further comprising:

a second mirror mounted along the second line, opposite to the means for moving;

an objective lens located between the second mirror and the wafer;

an optical bench having a planar surface;

wherein said source, said means, said photodetector, said additional lasers and said mirrors are mounted on the planar surface of the optical bench and the wafer is mounted on the stage in a plane parallel to the planar surface of the optical bench.

34. The apparatus of Claim 27 further comprising:

a synchronous detector coupled to the photodetector to receive a first electrical signal generated by the photodetector, the synchronous detector being further coupled to said means by a cable carrying a predetermined frequency of oscillation of said spot by said means, the synchronous detector measuring an amplitude of a portion of the first electrical signal fluctuating at the predetermined frequency and in phase with movement by said means.

35. The apparatus of Claim 27 further comprising:

another laser mounted along the second line, opposite to the mirror.